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(54) Ultrasonic welding in pouch manufacturing

(57) Pouch containers which are sealed by ultrasonic welding can be severed one from the other using the ultrasonic sealing unit to sever the film after sealing the film. This can be done by the energy director on the ultrasonic horn having sidewalls of a given angle and by increasing the pressure of the ultrasonic horn against the anvil.

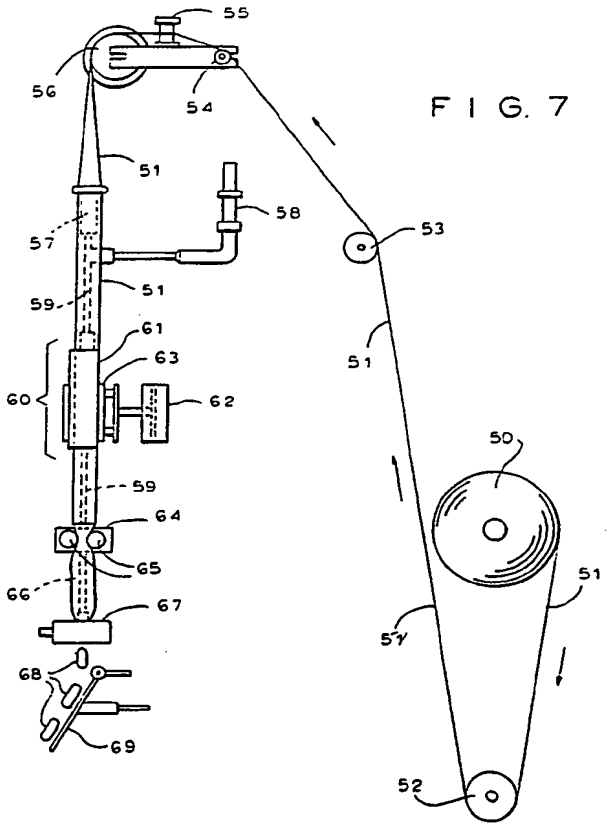

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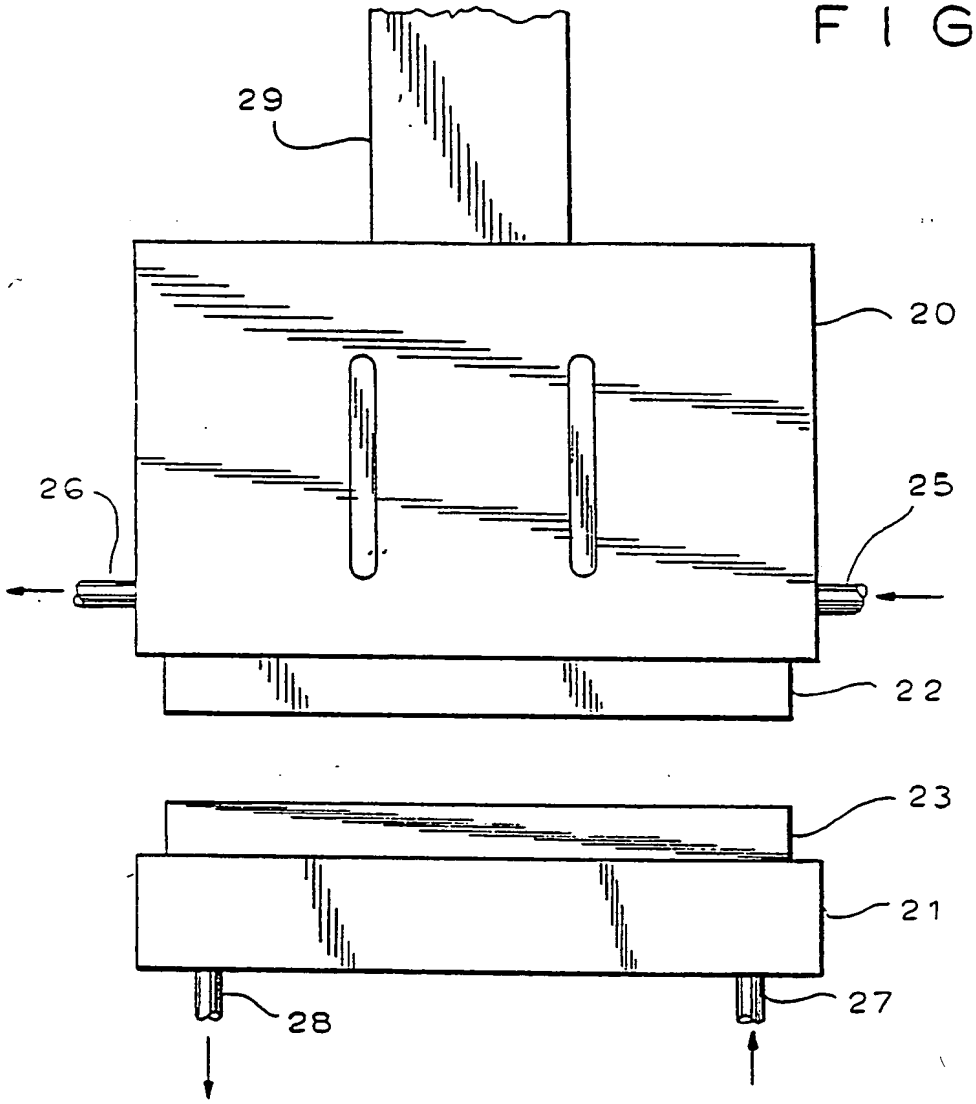
FIG. 2



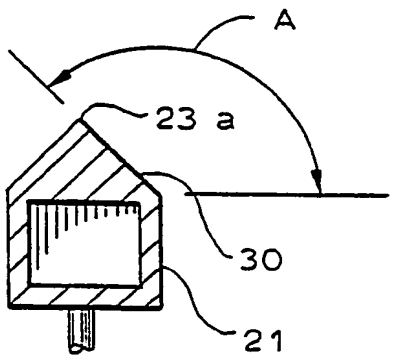


FIG. 3

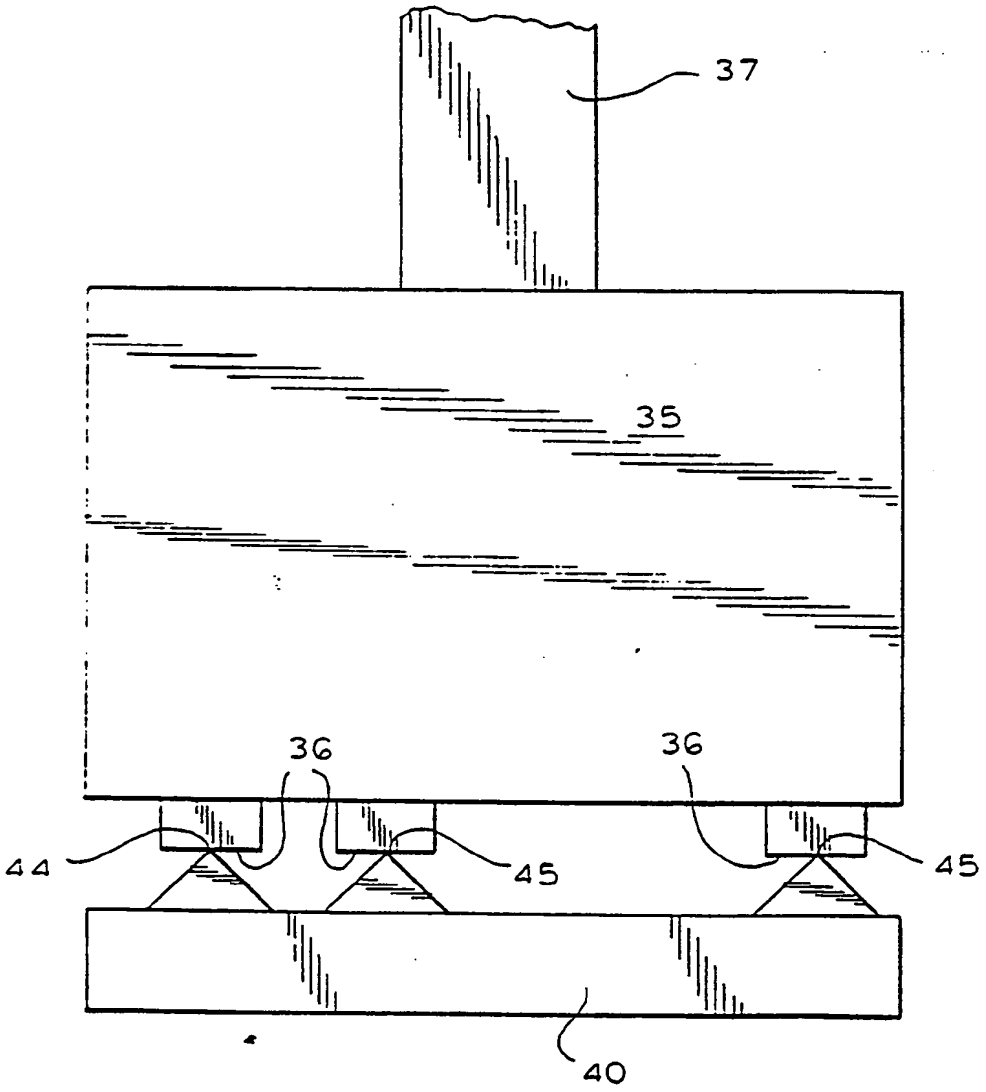


FIG. 6

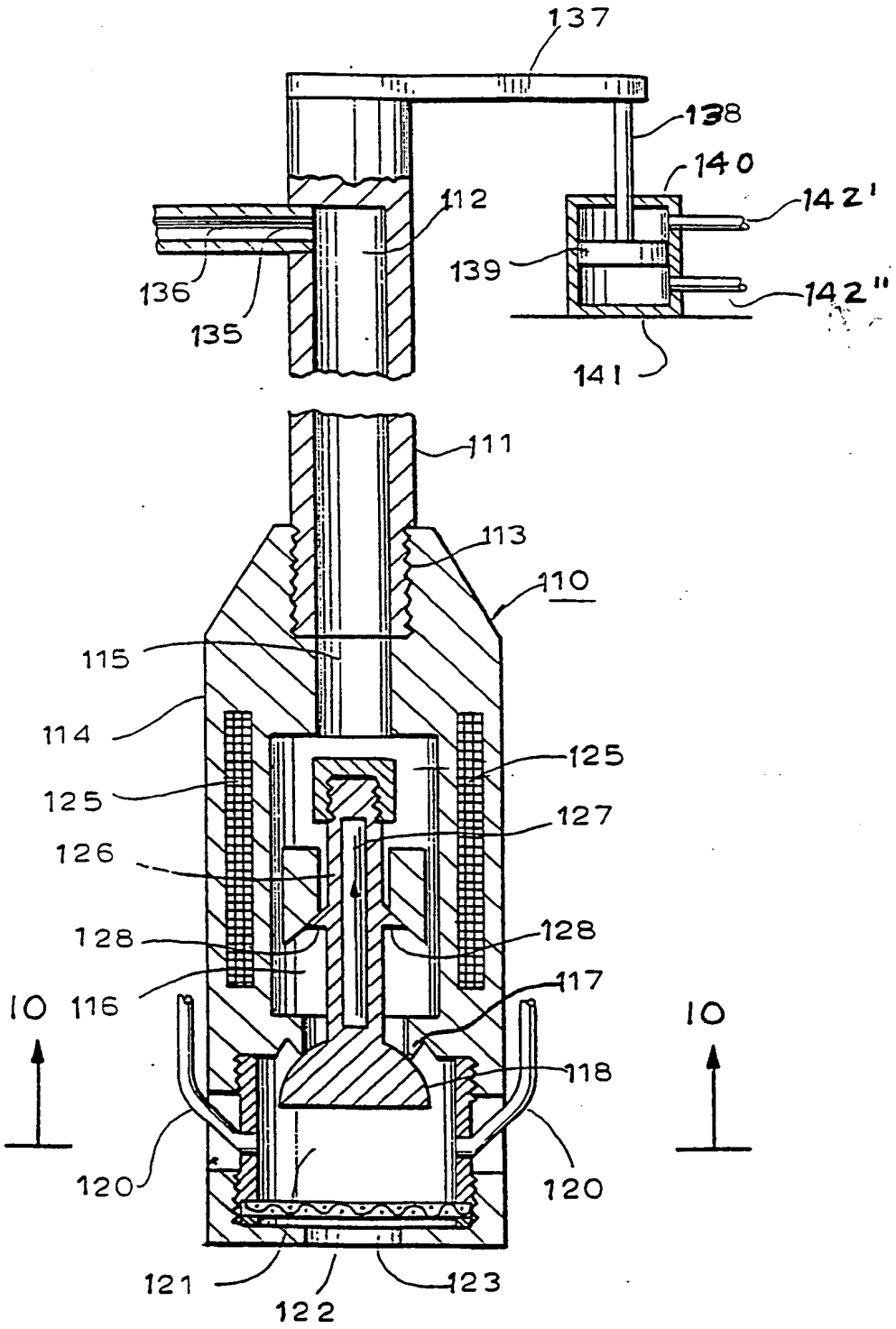


FIG. 8

FIG. 10

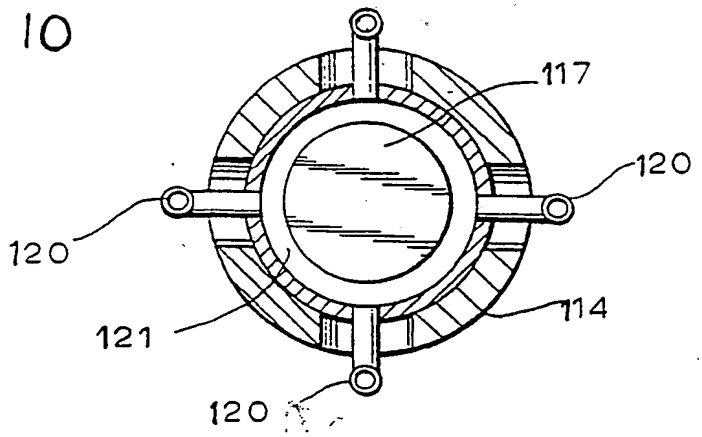


FIG. 11

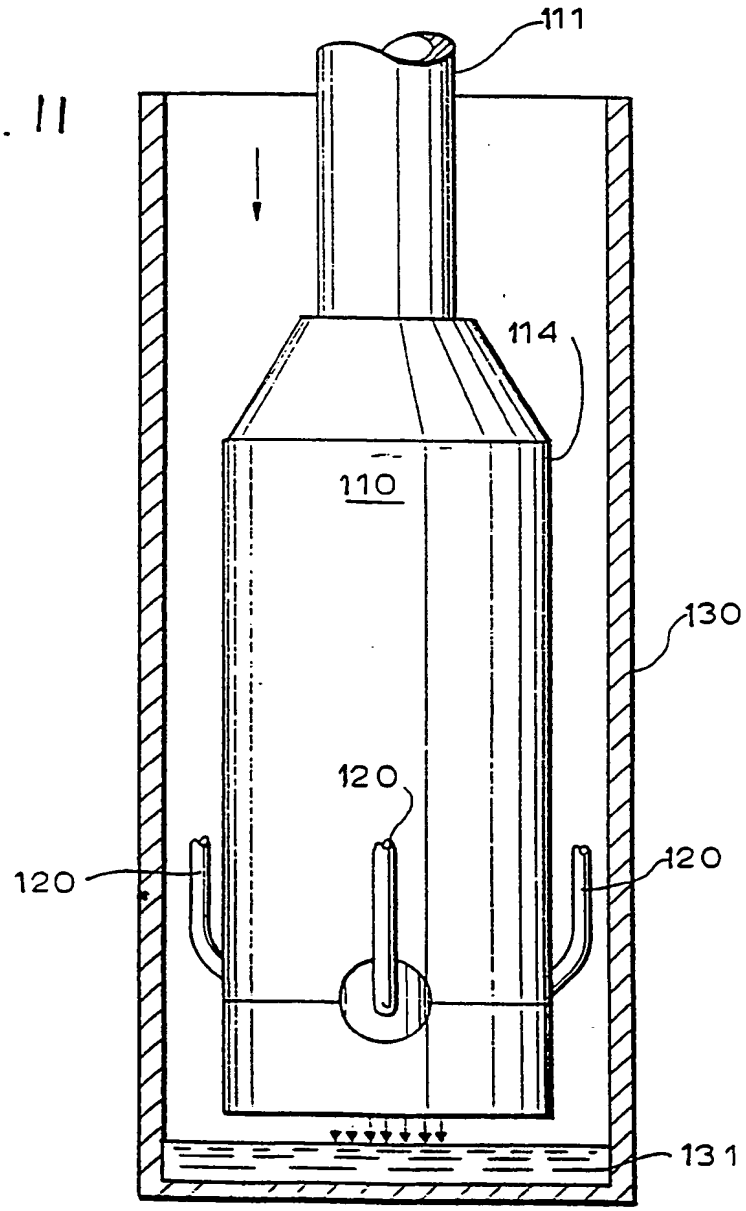
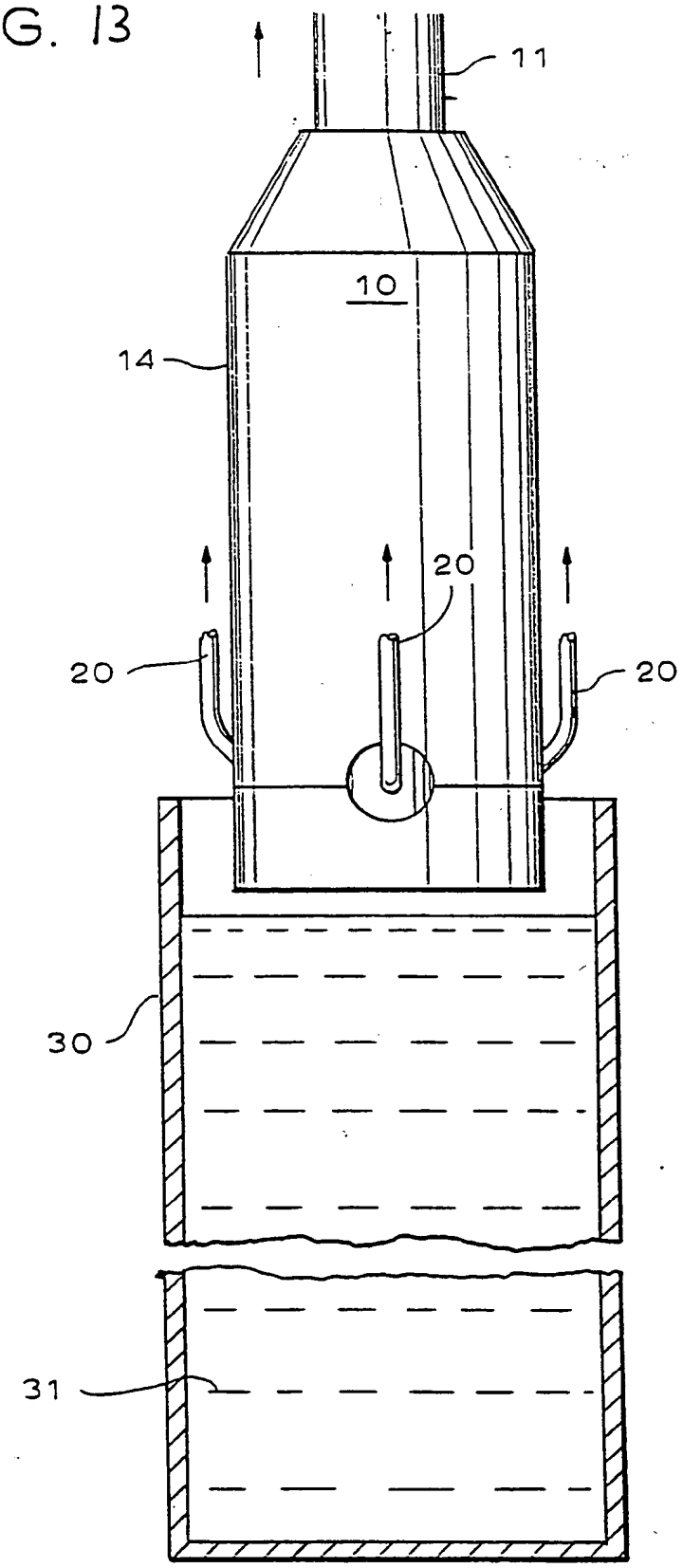


FIG. 13



thickness of the film is heated rather than the film surface. This provides good sealing but is restricted to films that absorb a sufficient amount of RF energy to soften. Also, since the full thickness of the film is heated, there is the potential for overheating the film and depositing pieces of film, known as flash, onto the electrodes. This will affect subsequent seals made by the electrodes until they are cleaned.

It has been found that the use of ultrasonic sealing for forming pouches from thermoplastic films is an improvement over the use of adhesives, heated platens or RF energy. In ultrasonic sealing, only the surfaces that are to be bonded are heated. They are heated by absorbing impact energy. The full thickness of the film is not heated. This provides for various advantages. Films that do not have a sufficiently high absorption for RF energy can be used to make the pouches. The problem of flash formation is also obviated. Due to the heat being formed only at the impact surfaces, flash will not be produced.

It has also been found that the use of ultrasonic sealing has distinct advantages in form/fill operations. These are operations where the pouch is filled as it is formed. A problem with form/fill operations for pouches is that during the filling sequence, there is a tendency for the product to contact the area of the pouch that is to be sealed. In other types of sealing, including RF sealing, this can produce weakened seals. However, in ultrasonic sealing there is a cleaning of the surfaces that are to be bonded prior to bonding. This is accomplished by surface to surface vibration. Consequently, it has

It has been found to be advantageous in forming and filling thermoplastic pouches to use ultrasonic sealing techniques in forming the pouches. Ultrasonic sealing has advantages over the use of adhesives, conduction heating or dielectric heating. A distinct advantage is the ability to simultaneously clean the surface of the film that is to be a part of the seal while heating this surface to at least its melting point. This is important in form/fill sequences where the pouch will be formed and filled in the same sequence. In such packaging operations, the substance being packaged, usually a liquid, will contaminate some of the seal area when it is flowed into the open pouch. In order to get a good seal, this area should be clean. This can be accomplished in various ways. However, the most efficient way is to use ultrasonic sealing techniques. In this way, the sealed area will be cleaned as it is being sealed.

Also a part of the present invention is the use of an ultrasonic sealing unit which is comprised of an ultrasonic horn and an anvil for the dual purpose of sealing a film and cutting a film. This is accomplished by the same surfaces on the ultrasonic horn and anvil. The shaped cutting surface will, preferably be a part of the anvil and will desirably be of a triangular cross-sectional shape. The outside base angles of the triangle will be about 120° to 160°. This will provide for 20° to 60° interior angles. The top of the shape terminates in a smooth edge.

Further, the pouch containers which are sealed by ultrasonic welding can be severed one from the other using the ultrasonic sealing units to sever the film

partially formed pouch with the said liquid substance, closing the said pouch by sealing the opening through which the pouch has been filled using ultrasonic energy applied by an ultrasonic horn to an anvil at a first contact pressure, and increasing the contact pressure to sever the film.

Preferably the method comprises:

(a) shaping a flexible film into a tubular shape with an overlapping edge;

(b) contacting the overlapping edge of the said film in a tubular shape with ultrasonic energy to bond the overlapping edge of the said tubular shape to form a tube;

(c) sealing by ultrasonic energy a lower portion of the said tube to form a first pouch;

(d) filling the said first pouch with a substance; and

(e) sealing by ultrasonic energy (I) an upper portion of the said first pouch to seal the said pouch, and (II) another portion, (upstream of the first pouch) of the said tube to form a second pouch, and severing the said first pouch from the said second pouch.

Preferably a die shapes the said film into a tubular shape having an overlap of about 0.1cm to about 1.0 cm.

In the sealing of the top seal to form a pouch and a beak spout adjacent to the top seal, the excess film in the area of the beak spout may be severed in a second step.

The invention in another aspect extends to a shaped sealed flexible film pouch containing a liquid substance, the pouch being comprised of one or more plies, having a side seam, a lower seam, an upper seam, and a spout, all sealed through the use of ultrasonic energy.

The said spout is preferably at the upper edge of the said pouch and preferably is in the form of a beak.

The invention further extends to an apparatus for forming and filling pouches comprising:

(a) means to shape a flexible film into a tube having an overlapping longitudinal seam;

(b) a first ultrasonic horn and anvil assembly;

(c) means to position the overlapping longitudinal seam of the said flexible film between the said first ultrasonic horn and anvil;

(d) means to actuate the said first ultrasonic horn and anvil assembly to seal the said overlapping seam to form a tube;

The apparatus preferably comprises means to produce a pressure of about 10 kg/cm^2 to 70 kg/cm^2 between said second ultrasonic horn and anvil during sealing and a pressure of about 20 kg/cm^2 to 100 kg/cm^2 during severing.

The invention also extends to an ultrasonic horn and anvil assembly for sealing and severing thermoplastic film comprising a shaped contact surface on one of the said ultrasonic horn or anvil adapted to seal the said film upon the application of a first pressure and ultrasonic energy and to sever the said film upon the application of a second higher pressure.

The said shaped contact surface is preferably essentially triangular in cross-section with the base exterior angle being about 120^o to 160^o.

The second aspect of the invention addresses a further problem and relates to a method and apparatus for filling packages, such as pouches, with liquids and preventing splashing of the filling substance. In particular, this aspect of the invention relates to a nozzle which includes means to prevent excess liquid from flowing into the pouch or bottle and means to maintain the exit of the nozzle above the level of the liquid in the pouch or bottle during filling, and the method of using this valve to fill pouches and bottles.

Many problems are met in the filling of pouch containers. One of these problems is the splashing of the liquid as it is being filled into the container. Another problem is dripping from the nozzle after the container has been filled. Such splashing and dripping will result in contamination of the seal area of the container. Excessive splashing can also result in the

excess liquid from the screen area. In addition, the entire elongated tubular member which comprises the nozzle can be moved upwardly as a container is being filled in order to maintain the exit end of the nozzle at a set distance above the level of the liquid in the container and thus minimise the impact energy of the liquid as it enters the package.

According to this aspect of the present invention an anti drip nozzle for filling containers e.g. flexible film packages comprises an elongated tubular member having an aperture therethrough for the flow of a liquid, means at an upper end for the introduction of a liquid and an outlet aperture provided with at least one screen means across the aperture, and suction means adapted to remove liquid from the said screen, and preferably means adapted to cause the said tubular member to be raised during the filling of the container.

According to this aspect of the invention a method of filling a container e.g. a flexible film package or pouch with a liquid comprises :

(a) providing a tubular nozzle having a channel therethrough, means at one end of the said channel to attach the said valve to a source of a liquid, and suction means on the other end to prevent dripping upon the cessation of input of liquid to the said tubular nozzle;

ceases and by means of suction excess liquid in the region of the one or more screens of the nozzle is removed by means of the suction. This reduces drip formation upon the cessation of the flow of liquid.

As the container is being filled, the valve desirably moved upwardly so as to be a set distance above the level of the contents of the container during filling. In addition, the liquid passes through an anti-splash screen as it exits the valve. In a further feature, associated with the screen are one or more suction units which operate at the cessation of liquid flow from the valve to remove liquid from the screen and prevent dripping. The combination of the valve moving upwardly during container filling, a screen, and suction units associated with the screen function to prevent splashing during filling and dripping after filling.

The invention may be put into practice in various ways and one specific embodiment and a number of modifications will be described by way of example to illustrate the invention with reference to the accompanying drawings in which:

Figure 1 is a rear elevational view of a pouch with a beak spout formed using ultrasonic techniques;

Figure 2 is an elevational view of a sealing unit for sealing the longitudinal seam of the pouch of Figure 1;

Figure 3 is a cross-sectional view of an anvil for sealing and severing a film;

Figure 13 is an elevational view of the fill nozzle of Figure 8 with the container having been filled.

The process of the first aspect of the invention will be described with reference to the manufacture of pouches having spouts, as shown in Figures 1 to 7. An illustrative pouch is set forth in Figure 1. This pouch is designated 10 and has a rear surface, 11, a longitudinal seal 12, a bottom seal 13 and a top seal 14. There is also a beak spout 15 with a cut-out 17 and an associated seal 16.

In the process of forming and filling the pouches of Figure 1, a film is in a first step formed into a tube which is accomplished by each edge of the film being overlapped from about 0.1 to 1.0 cm to form a seam. This seam is passed between the ultrasonic horn and an anvil of a longitudinal ultrasonic sealing unit. Since the seam is now between the ultrasonic horn and the anvil upon the application of pressure and ultrasonic energy to the ultrasonic horn and/or anvil the thermoplastic material at the seam juncture is heated and bonded. Pressure is preferably applied to the ultrasonic horn. After this step, the film is now in the shape of a tube. Preferably, at the same time that the side seam is being sealed, a pouch top seam is being formed and sealed on a lower pouch. Also preferably at this time the beak spout is being formed on this lower pouch and a bottom seal on yet a further lower pouch. This is the case since the film is in a stationary position and for increased efficiency more than one operation can be conducted on the film at this

top seam of an upper pouch and form the beak spout of this upper pouch. This step can be carried out concurrently with other sealing steps since the film is in a stationary position. In this way, in this form/fill sequence, three different sealing operations can be conducted during each interval when there is a pause in the movement of the film. The side seam is sealed to form a tube, the top seal and spout are made for a pouch for which the side seam has previously been made, and the bottom closure seal is made on another pouch which has just been filed with a substance. After the top seal and beak spout of the upper pouch and the bottom seal of the lower pouch have been formed, the ultrasonic energy is stopped and the pressure between the anvil and the ultrasonic horn is increased to thereby sever the lower filled pouch from the upper empty pouch. The lower filled pouch is then forwarded for packing and the upper formed pouch is filled. Also in the above sequence as the transverse seals are being formed, the beak spout is being formed.

A persistent problem with regard to these pouch containers is that of the contamination of the transverse sealing areas at the time that the pouch is being filled. This is a contamination by the contents that are being flowed into the pouch. This is caused by a splashing of the substance being flowed into the pouch and a dripping of the product upon the termination of the filling process. Since the inner thermoplastic surfaces are to be bonded, one to the other, excessive contamination can affect the integrity of the transverse seals. However, since in ultrasonic sealing it is the film juncture that is being heated,

of about 10KHz (kilohertz) to 70 KHz and most preferably about 20 KHz to 40 KHz. Energy is supplied to the ultrasonic horn through a booster 29.

The longitudinal sealing unit is designed for sealing and need not be capable of also cutting film. However, when it is desired that this unit also be used for cutting, the anvil of the ultrasonic horn would have a contact surface as shown in cross section in Figure 3. The angle A of the surface 30 is from about 120^{o} to 160^{o}, and preferably about 150^{o} to 175^{o}. This results broadly in an interior angle of 20^{o} to 60^{o}. The top surface 23(a) is an edge and is sufficient to produce an effective seal, but yet as the pressure between the ultrasonic horn and the anvil is increased, the film can be cut.

In Figure 4, there is shown the anvil assembly for producing the top and bottom seals and the beak spout for the pouch of Figure 1. This unit simultaneously forms the bottom seal of a lower pouch and the top seal and the seals around the beak spout of an adjacent upper pouch. After these seals are formed, the pressure between the ultrasonic horn and the anvil is increased, and the thermoplastic material between the bottom seal of one pouch and the top seal of another pouch and the excess material in the area of the beak spout is severed. This ultrasonic sealing unit must have sufficient energy to complete the seal and to thin the material for subsequent severing of the thermoplastic film.

severing the film. The increased pressure is dependent on the pressure that is utilised during the sealing operations. The pressure can be increased by the anvil being moved against the ultrasonic horn or the ultrasonic horn being moved against the anvil.

In Figure 6 there is shown the complete transverse ultrasonic sealing unit for forming the top and bottom pouch seals and the beak spout seals. This consists of essentially the anvil assembly 40 and the ultrasonic horn 35. This unit produces the top and bottom seals as well as the beak spout seals. This ultrasonic horn consists of flat surfaces 36 to contact the shaped surfaces 44 and 45 of the anvil. The ultrasonic energy is transferred from the booster 37 to the horn. However as noted above, the ultrasonic horn can be shaped to function to sever the film rather than the anvil being shaped to serve its purpose. Either the ultrasonic horn or anvil must be shaped to provide for a severing of the film after sealing. If the ultrasonic horn is to function to sever the film, the contact portion 36 of the ultrasonic horn must be of the shape as is illustrated for the anvil. In such an instance the anvil will have a flat surface.

As the pressure is increased on the film after the film has been sealed the film will flow due to the exerted pressure. This causes the film to sever at a mid-point of the seal. Neither the horn nor anvil has a sharp cutting surface rather they have dull edges. The seal extends a very short distance beyond the horn and anvil profile. The horn and anvil together both seal and sever the film.

from the upper pouch which had a pouch top seal and beak formed. The upper pouch is then filled. The sequence is then repeated. The pouches are filled from what is ultimately the lower end of the sequence. Three pouches 68 are shown as being conveyed for packaging. Two different pouches are being operated on at 67 at one time. The upper pouch where the beak and pouch top seal 14 is being formed, and the lower pouch where the pouch bottom seal 13 is being formed.

In more detail the film 51 is unwound from a supply roll 50. This passes down over a tension roller 52 and over directional rollers 53 and 54. The film then passes over a roller 56 and downward to the form/fill section. At 57, the film is formed into an open tubular shape. Shaper 57 is supported by a fill conduit 59 which receives a product to be packaged, usually a liquid product from a supply conduit 58. The fill conduit 59 is stationary and does not move (in a modification described below in ~~claims~~ Figures 8 to 13 the filling assembly moves so as to reduce any tendency to splashing of the pouch surfaces before sealing). The film passes in an open fashion by the supply conduit 58 to the seam forming and longitudinal sealing section 60. In this sealing section, a guide 61 directs the film into a shape so that there is an overlapping longitudinal seam for sealing by the longitudinal ultrasonic sealing unit. The longitudinal ultrasonic horn 63 receives ultrasonic energy from a transducer 62. The anvil is carried by the fill conduit 59. The film, now in a tubular form, emerges from the longitudinal sealing section 60 and is moved downwardly by a controller 64. The controller 64 moves the film

transverse ultrasonic sealing unit 67. Also, while the movement of the film (film flow) has stopped, the pouch that has been formed is filled.

A preferred embodiment of filling conduit will now be described with reference to Figures 8 to 13 as mentioned above.

In Figure 8, the fill nozzle 110 is shown in a closed position. In this position, no liquid can exit through the opening 123 of the nozzle 110. The nozzle consists of a body 114 which receives liquid through a channel 112 of a conduit 111. Liquid is received from a conduit 136 through an opening 135. This conduit 111 also supports the nozzle and provides the means for raising and lowering the nozzle during container filling cycles. The conduit 111 threadedly engages the nozzle body 114 by means of a thread 113. The conduit 115 in the nozzle body permits liquid to flow into the valve stem housing 116 and to the area of the valve seat 117 of the nozzle. The liquid passes around the valve stem guide 126 of the valve stem 118 to the region of the valve seat 117. The lower part of the valve stem contacts the valve seat when the valve is in the closed position. This will stop the flow of liquid. When in an open position as shown in Figure 9, the conduit 115 will communicate with the chamber 121 with liquid flowing from the conduit 115 into the chamber 121. At the lower part of the chamber 121, there are one or more screens 122 adapted to induce laminar flow in the liquid that is being flowed. After flowing through the screen the liquid will exit from the nozzle through the aperture 123. Communicating with the chamber 121 are one or more conduits 120 which

above the level of the liquid 131 in the container. In Figure 13, the container 130 is shown to be full. The nozzle is located above the level of the liquid and the flow of liquid from the nozzle has ceased. At this point, a suction is drawn on the conduits 120 so as to remove excess liquid from the lower part of the nozzle, ie, from the region of the screen or screens.

The primary functions of the screen or screens 122 are to impart a laminar flow to the liquid emerging from the nozzle and to aid in preventing drip from the nozzle when it is in a closed position. This screen can be a single screen or a plurality of stacked screens. It is preferred that a single screen be used and that it have a thickness of about 0.1 mm (millimetres) to 10 mm and preferably about 0.2 mm to 5 mm. The screen will have a mesh opening of about 0.1 to 5 mm, and preferably about 0.5 to 2.5 mm. This will be sufficient to produce channels through which the liquid will flow thus inducing an essentially laminar flow.

It is also preferred that the nozzle be of a diameter to essentially fill the cross-section of the container during filling. For a pouch, this will be about 60 to 90 per cent of the diameter of the container. When the container is a jar, this will be about 60 to 90 per cent of the neck opening of the jar. A large diameter nozzle will produce less splashing since the liquid will flow at a lower velocity. In addition, the risk of highly turbulent flow is minimised. In this way splashing and the contamination of the inner walls of the container is reduced.

one or more screens of the nozzle into a recycle tank. The suction is then terminated and nozzle is ready to be lowered and another cycle commenced.

A prime objective of this filling nozzle is to prevent the liquid that is being filled into pouches and other containers from splashing up around the fill nozzle and wetting the film in the area where a seal will have to be made in a subsequent step. If the area that is to comprise the seal has been wetted with product, there is the potential for a weaker seal being formed.

Essentially any film which can be welded by means of ultrasonic energy can be utilised to form the present pouches. The particular thermoplastic films can be either amorphous or crystalline. Suitable films include those of acrylic copolymers, cellulosic, phenylene oxide, polycarbonate, and polystyrene. Generally, crystalline resins are not as easily sealed using ultrasonic techniques as amorphous resins. Crystalline films are more rigid. Flexible films are preferred. However, acetal resins, fluoropolymer resins, nylon resins and polyester resins can be utilised in ultrasonic sealing techniques. A preferred film is one which contains at least one layer of ethylene-vinyl acetate. The other layer or layers can be polyolefin such as polyethylene, polypropylene, polybutylene or polybutadiene.

The pouches which can be formed using the present ultrasonic sealing techniques can be of essentially any size. However, the preferred sizes range from about 50cc. to about 2 litres in size. These are the sizes that are conveniently handled with regard to this type

portion of the tube as is a beak spout. This is formed by a transverse ultrasonic horn and mobile anvil assembly 67 (as shown in Figures 4 to 6). At the same time that the top seal and beak spout are formed on this pouch, a bottom seal is being formed in a lower pouch which has been filled. An ultrasonic frequency of 35 KHz is used to form these seals. The impinging pressure of the transverse ultrasonic horn and anvil assembly during sealing is about 40kg/sq cm. After the side and top seals along with beak spout are formed on the present pouch, the thus newly formed pouch with an open bottom (at its top end) is filled with 250 cc of bleach. The lower pouch 68, which has undergone closure sealing, has been severed and is conveyed to packing. The severing is accomplished by increasing the impinging pressure of the ultrasonic horn against the stationary fixture to about 90 kg/sq cm. No ultrasonic energy is applied at this time. This then completes a machine cycle. This cycle is then repeated.

The sealed seams of a representative number of pouches are tested in a pressure tester. The pressure tester has a stationary and a movable platen. A sample is placed between the platens and the pressure on the pouch increased. A burst strength of greater than 150 kg indicates an acceptably filled pouch. The pouches consistently exceed 150 kg.

EXAMPLE 2

The apparatus of Figures 1 to 7 is used in combination with the apparatus of Figures 8 to 13 so

C L A I M S

1. A method of forming a shaped, sealed flexible film pouch containing a liquid substance comprising partially forming flexible film into a pouch using ultrasonic energy, substantially filling said partially formed pouch with the said liquid substance, closing the said pouch by sealing the opening through which the pouch has been filled using ultrasonic energy applied by an ultrasonic horn to an anvil at a first contact pressure, and increasing the contact pressure to sever the film.

2. A method as claimed in Claim 1 comprising:

(a) shaping a flexible film into a tubular shape with an overlapping edge;

(b) contacting the overlapping edge of the said film in a tubular shape with ultrasonic energy to bond the overlapping edge of the said tubular shape to form a tube;

(c) sealing by ultrasonic energy a lower portion of the said tube to form a first pouch;

(d) filling the said first pouch with a substance; and

6. A method as claimed in any one of Claims 1 to 5 in which the said flexible film has at least one ply that is bondable to itself by means of ultrasonic energy.

7. A method as claimed in Claim 6 in which the said flexible film has at least one polyene layer and an ethylene-vinyl acetate layer.

8. A method as claimed in Claim 7 in which the said polyene layer is selected from the group consisting of polyethylene, polypropylene, polybutylene and polybutadiene.

9. A method as claimed in any one of Claims 1 to 8 in which the said flexible film is fed as a continuous sheet, formed into a continuous tubular shape and sealed to form a continuous tube.

10. A method as claimed in any one of Claims 1 to 9 in which the said flexible film is in a stationary position when the said upper portion and lower portion are sealed and one pouch severed from another pouch.

11. A method as claimed in any one of Claims 1 to 10 in which, in the sealing of the top seal to form a pouch and a beak spout adjacent to the top seal, the excess film in the area of the beak spout is severed in a second step.

(d) means to actuate the said first ultrasonic horn and anvil assembly to seal the said overlapping seam to form a tube;

(e) a second ultrasonic horn and anvil assembly located subsequent to the said first ultrasonic horn and anvil to form top and bottom closures on the said tube and produce a pouch;

(f) means to actuate the said second ultrasonic horn and anvil assembly at a first contact pressure to seal the said top and bottom closures and at a second contact pressure to sever the film that has been sealed to separate a filled pouch from the said tube; and

(g) filling means adapted to substantially fill the said pouch subsequent to forming the said bottom closure and prior to forming the said top closure.

17. An apparatus as claimed in Claim 16 comprising means to produce a contact pressure between the said first ultrasonic horn and stationary fixture of about 10 kg/cm^2 to 70 kg/cm^2.

24. An ultrasonic horn and anvil assembly as claimed in Claim 20 in which the said shaped contact surface is essentially triangular in cross-section with the base exterior angle being about 120^{o} to 160^{o}.

25. An ultrasonic horn and anvil assembly as claimed in Claim 23 substantially as specifically described herein with reference to Figures 2 and 3 or 4, 5 and 6 of the accompanying drawings.

26. Apparatus as claimed in any one of Claims 16 to 22 in which the filling means incorporate an anti-drip nozzle comprising an elongated tubular member having an aperture therethrough for the flow of a liquid, means at an upper end for the introduction of a liquid and an outlet aperture provided with at least one screen means across the aperture, and suction means adapted to remove liquid from the said screen, and means adapted to cause the said tubular member to be raised during the filling of the container.

27. Apparatus as claimed in Claim 26 in which the screen means are such as to induce laminar flow and to decrease drip formation upon cessation of flow of the said liquid.

28. Apparatus as claimed in Claim 26 or Claim 27 in which the suction means are located in the region adjacent to the said screen to remove excess liquid from the said screen.

34. Apparatus as claimed in any one of Claims 26 to 33 in which the body of the said valve substantially fills the cross-section of the flexible film package or the neck of the container which is being filled.

35. Apparatus as claimed in Claim 30 or any one of Claims 31 to 34 when dependent on Claim 30 in which there is at least one suction means in the region adjacent to the said screen to remove excess liquid from the said screen.

36. A method as claimed in any one of Claims 1 to 12 further comprising:

(a) providing a tubular nozzle having a channel therethrough, means at one end of the said channel to attach the said valve to a source of a liquid, and suction means on the other end to prevent dripping upon the cessation of input of liquid to the said tubular nozzle;

(b) as the container is being filled raising the tubular nozzle so as to maintain the said tubular nozzle above the surface of the liquid in the container; and

(c) actuating the suction means upon the cessation of the flow of liquid to the said nozzle to remove excess liquid from the means to prevent dripping on the other end of the said tubular nozzle.

39. A method as claimed in Claims 36, 37 or 38 in which the said liquid is selected from the group consisting of detergent, bleach, fabric softener and lotions.

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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